

The Agriculture Block Chain: An Overview

^{1*}Tejas R. Suthar, ²Onkar K. Suryawanshi and ³Abhishek B. Gavane

^{1,2,3} MIT College of Food Technology, MIT Art, Design and Technology University, Lonikalbhor, Pune, India.

Abstract: The blockchain is ledger or records in which all the information related to accounts and transaction are recorded by all participants. It provides safe and secure platform for authorized parties to fill and access the data because sometimes data could be incredibly costly and cannot be allowed by either of the parties to modify data. The blockchain can back trace the origin of food from the primary production to end consumer. It is trusted way to track the information in food supply chain efficiently. This technology can change the agriculture sector in terms of commodity moving, fairness in pricing, transparency in food supply chain and can increase the agriculture productivity and sustainability. This can speed up the transaction process while lowering the data mismanagement and fraud. In this review it is covered that how blockchain is fascinating the “e-agriculture” concept and how this is going to be profitable for agriculture sector. We also discuss the agriculture problems and how blockchain can solve this problem with implementing technology advancement.

Keywords - ICT E-Agriculture, Food crop production, Food supply chain, Agriculture problems.

I. INTRODUCTION

Blockchain is technology that give authority to users to transfer data between each other without the need for a trusted Intermediary. ‘Blockchain for Agri-food’ was started in March 2017. The project implemented the idea of exploring the blockchain techniques in agriculture sector. Blockchain technology is mainly or firstly used for cryptocurrencies but at present this technology providing its benefits way beyond only cryptocurrencies. This technology benefiting not only cloud storing technology but also in agriculture sector. Blockchain technology is still facing some challenges like incorporating transformative Information and Communications Technology (ICT) and building trust. It is also improving efficiencies for agricultural sustainable development. Blockchain technologies can bring many benefits in smart agriculture and food traceability system, but it is certain to some specific functions (Sylvester 2019). Blockchain is a ground-breaking technology that implements a shared records or database to provide an incontrovertible, single version of the truth among different individuals. Blockchain provides transparency in supply chain, moving of goods, flowing of fair money between farmers and buyers and to work as barrier for corrupt business practices by enabling equally contribution for farmers and other stakeholders on the global food supply chain (Lask andowski 2017). The blockchain technology market is expected to hit up from 210.2 million USD in 2016 to 2312.5 million USD by 2021 (DNV GL AS, 2017).

A blockchain is a ledger or registry in which agents records the information on the process of generating, transacting and consuming a product or service. The records or ledger is cooperatively managed by all authorised parties typically through a peer-to-peer network. Without verification of new network, no any data can be recorded in blockchain. Any modification in the records can only be done when majority of authorised parties are agreeing. In addition, a modification to one record will lead to the modification of all its subsequent records. Due to this high secure platform, it is almost very difficult to change in data recorded in a blockchain in practice. Blockchain is seen as “an open, distributed ledger or register that can record transactions between two parties efficiently and in a verifiable and permanent way” (Iansiti and Lakhani, 2017).

For improving the productivity and sustainability of agriculture sector, the usage of data and information becomes key factor. Information and Communication Technology (ICT) significantly increases the efficacy and effectiveness of gathering, storing, analyzing, monitoring and using data in agriculture (Walter et al., 2017). It helps agricultural experts and farming communities to get updated information and will help in taking better decisions in the regular farming (Kaddu and Haumba, 2016).

II. BLOCKCHAIN: THE EVOLUTIONARY NEXT STEP FOR ICT E-AGRICULTURE

The evolution of blockchain technology is bringing new benefits in agriculture sector. The Food and Agricultural Organization of the United Nations (FAO) referred ICT-enabled farming systems to as ‘e-agriculture’. This is the initiative taken by the government that will help in increasing market efficiency, food safety concerns and security of food articles and reduce institutional risk. ICT e-agriculture improves farmers access to agricultural services and agriculture superiority data, advances traceability, improve transparency and cross verification with international standards. An ICT e-agriculture with a blockchain architecture can ensure the back tracing of the agriculture data as the agriculture commodity move from primary production sources to end consumer (Sylvester 2019).

ICT e-agriculture with a blockchain infrastructure is considering as the technology advancement which is dealing with the ICT enabled farm systems and e-agriculture schemes. The internet allows every individual which is linked with blockchain data accesses authority to share digitized information about all the agriculture aspects. The ICT data gets stored in database or network database with centralized cloud computing system or architecture (Yu pin lin et al., 2017). An ICT e-agriculture can share its data at larger network, not only nationally but it also shares the data at international level. Blockchain technology can benefit different elements of individual farm system. In Taiwan, there are 17 Farmland Irrigation Associations that are giving their time for adopting the sustainable development of agriculture by improving paddy field conservation management and it has direct and indirect impact to the environment, agriculture production and rural growth (Sylvester 2019).

Information and Communications Technology (ICT)-based technologies are contributing widely in the area related to agriculture such as the remote monitoring of farm conditions (soil, moisture, humidity, temperature and pH) and the remote control of farm equipment through smartphone applications and this technology are immersing worldwide to promote the “e-agriculture”. In near future, this ICT technology is expected to contribute the major role in agriculture growth (Abbasi et al., 2014 and Lin et al., 2017). Table 1 is showing some examples of implemented ICT technology in the agriculture sector. Developers have developed some smartphone application, ICT-based monitoring system to observe, control and evaluate different aspects of agriculture.

Table 1: Examples of contribution of ICT technology in agriculture

Sr. No.	Developer/author	Concept / idea / proposal
1.	Bartlett et al., 2015	Smartphone application was developed that access soil moisture data and weather report through evapotranspiration irrigation schedule tool
2.	Jagannathan and Priyatharshini, 2015	ICT-based smart system was developed to monitor and observe nutrient content, soil moisture content and the pH of soil
3.	Jiang et al., 2016	Gave idea to develop Wireless sensor network (WSN) with dynamic coverage cast tree algorithm (DCTA) in orchid greenhouse to achieve high cultivation
4.	Lin et al., 2017	ICT-based monitoring system was developed to look upon soil degeneration and irrigation water contamination in pilot area for productive agriculture plan
5.	Yu et al., 2017	Smartphone application was developed in context with crowdsourcing and human sensing tool to monitor land conditions
6.	Perea et al., 2017	ICT-based system was developed which gives agroclimatic data, irrigation system data and soil data of strawberry production farm

III. AGRICULTURE PROBLEMS IN INDIA

It is predicted that India's agriculture sector accounts only for around 14 percent of the country's economy but responsible for 42 percent of total employment in the country. It is reported that around 55 percent of India's arable land depends on certain soil and environment factors that are responsible for economy growth, the amount of rainfall and precipitation are the key factors. India is the seventh largest agricultural food exporter worldwide. Presently more than 52% of India's population is contributing in agriculture sector, yet it contributes just 14 percent to GDP. GDP From Agriculture in India increased to 6091.05 INR Billion in the fourth quarter of 2019 from 3664.29 INR Billion in the third quarter of 2019. Though GDP from agriculture in India has increased by the last year but yet Indian farmers are facing many problems in agriculture such as different types of risks involved in market, production, and prices. In this review, we have covered some of the main reasons that are responsible for decreasing the agriculture growth in India. Following are the main reasons (Zebi 2018 and Vidya Sethy 2020):

- a.) Inequality in Land Distribution
 - Agriculture land has not been fairly distributed in India
 - Large amount of land is owned by rich farmers, landlords and money-landers
 - Small amount of land is owned by majority of small farmers
 - Due to less land, less farming the output per hectare is low
- b.) Unfavourable climatic conditions
 - Inconsistent weather
 - Inadequate and poorly distributed rainfall
 - Lack of availability of irrigation water
 - Frequent crop failures
- c.) Land tenure system
 - Insecurity of tenancy was a problem during the pre-independence period
 - The land tenure system improved during the post-independence era after various land reform initiatives were implied, but the question of insecurity still conquers some
- d.) Cropping patterns
 - Food crops and non-food crops are the two type of crops produced by agriculture sector in India
 - As the high-income benefits from non-food crops, the land has been diverted from food crops to non-food crops
 - This has been creating food crisis problems in India
- e.) Instability in agriculture prices
 - Farmers are finding difficulty in selling their produce at decent prices
 - The movements of prices of agriculture products are neither smooth nor uniform
 - Lack of transparency, smoothness in supply chain
 - The excessive prices charged by middleman on agricultural crops lead to farmers getting less price for their crops
- f.) The Systems and Techniques of Farming
 - Neglection of crop rotation leads to fertility loss in land
 - Inadequate use of manures and chemical fertilisers makes agriculture less productive
 - Inadequate water supply
 - Shortage of modern machinery in agriculture
- g.) Lack of Organized Agricultural Marketing
 - Agriculture marketing problem is due to lack of communication between productive centres and urban area
 - The absence of adequate transportation facility is also a factor responsible for agriculture marketing problems
- h.) Agriculture Indebtedness
 - Indebtedness is the key reason why 90 per cent of farmers in India committed suicide.
 - Increasing costs of agriculture inputs
 - 60 percent of farmers have no access to the credit system, increasing their dependence on money lenders

- The excessively high rate of interest charged by the moneylenders
- Reduction in prices of agriculture produces
- Repeated crop failures
- Unable to access the credit system
- Withdrawal of government support

This are the some of the problems that are facing by the farmers of India which lead to a major barrier in agriculture growth. Due to lack of government support, lenders charging high rate of interest, lack of modern agriculture equipment, lack of use of fertilizers etc. lead to agriculture indebtedness and less growth of agriculture sector in India. As a solution the blockchain technique with the implication of ICT can play a major role in solving agriculture problems.

IV. USE OF BLOCK CHAIN IN AGRICULTURE

4.1 Crop and Food Production

As the human population is increasing, it is proposed that the world population will reach over 9 billion by 2050 (Suthar et al., 2019). Due to this with short period of time human population will demand for more food. Therefore, only agriculture and non-agriculture commodity will help to fight with food shortage crisis. And growing food with nominal resources with improving customer satisfaction, transparent supply chain, providing fair income to the farmers, dealing with weather variations- the agriculture sector has lot to deal with improving productivity and GDP of the country. From the primary producer to the end consumer blockchain technology with IoT is reorienting the food production in its own way. This technology is ready to make farming more productive by enhancing farming resources and incorporating new techniques. Here is the example that how this technique can help farmers and stakeholder in taking finest decisions.

Example:

IoT devices generating data using different types of sensors (temperature, pH, soil moisture, humidity, light) and this information initial need to be simplified before saving data on cloud storage.

Cleaning and Enrichment of the collected data is done before recording the actual data which is called Data Enrichment. When the data is enriched it is placed into ready format for machine learning.

Making the data more understanding with machine learning algorithms. This will help farmers and stakeholders to make improvement in the crop growing system and this data is transparently accessible.

Data is stored on the blockchain and, after the data has been enriched, the information will be visible to every participant in the agricultural market and will help in crop or food production efficiency

4.2 Food Supply Chain

Food supply chain is essential practice that can directly or indirectly linked with the safety concerns about food, from where the food is originated or grown. It is important to confirm that the supplied foods are safe to eat. Even if we address the present scenario, food supply chain control is not strong and the origins of goods must be checked in a demanding way by the food suppliers and distributors. With the advent of the application blockchain, the agricultural supply chain network has been trustworthy and food protection for everyone. Here is the example which shows the actual process work flow.

Example:

IoT sensors generating data or data captured by farmers manually is saved in the distributed storage platform.

Distribution of grown-up crops to the food processing companies are initialized. The crops can be transported to IoT-enable vehicles which capture data about temperature conditions under vehicles. Stored data on the block chain can ensure quality management at every step of the food supply chain.

Supplying of Processed Food to Wholesalers and Retailers are done with or without the use of IoT-enables vehicles.

Consumers may track blockchain data such as information of farm origin to transport dates, batch amounts, food production and factory data, expiry information, storage temperature and other digitally linked info to food products.

4.3 Controlling Weather Crisis

Controlling weather crisis is major issues as barrier in crop production and productive good outcome. Farmers have to deal with unpredictable weather conditions always while growing different crops. Therefore, prediction of changing weather and monitoring it are crucial activity for the crop survival. Sometimes the excessive spring rains leads to the crop's destruction. The oxygen concentration level changes and make it difficult for plant to perform metabolic process. Furthermore, lack of transparency can lead to unfair pricing in current food chain ecosystems. Due to the implication of blockchain techniques, it helps farmers and other stakeholders to clear idea about price differing in food distribution market. Here is an example which shows that how this technique can trace the weather conditions and can help the farmers to get their crop insurance claim easily.

Example:

Agricultural weather stations are providing essential information such as soil temperature at various heights, air temperature, leaf wetness, rainfall, wind velocity, dew point temperature, relative humidity, sunlight, wind direction and atmospheric pressure which enhance farmers' understanding of crop behavior.

↓
Farmers can take preventive actions by analysing the data generated by the weather station

↓
Quick application for the crop insurance help farmers to get requested amount in their accounts through the block chain.

4.4 Managing Agriculture Finance

Management of agriculture finance is important aspects which are faced by farmers regularly. In formal financial enclosure, problems arise like lack of transparency in money flow, credit histories and contract enforcement. The inability to reach financial services can have major adverse effect on agri value chain performance due to which producers cannot make the most of the yields and buyers face certain problems confirming efficient supply of agriculture goods. There is difficulty for smallholders to invest in agriculture due to biased financial services. It adds to the issue that purchasers compensate farmers for distribution, pushing low-rates farmers to sell crops. Fairness in agriculture finance process is a major issue that could be solved with blockchain technology. Here is the example showing short work flow of management of agriculture finance.

Example:

Stakeholders sharing information about all the transaction which take place at every step of food production and all the involved parties can have access of every single transaction

↓
Auditors can effectively conduct audits with verifying the transaction details directly via blockchain instead of asking farmers to provide financial reports

V. AGRICULTURE ADAVANTAGES IN OF THE BLOCK CHAIN

5.1 Improved quality control and food security

One of the main uses of blockchain is greater openness in the supply chain. It can help us to eliminate ineffective processes and ensure optimum conditions for quality control. For example, the failure of crops is a common problem for farmers all over the world. It usually occurs due to bad weather conditions such as poorly distributed precipitation and erratic weather. Companies like IBM are already investing millions in precision agriculture to resolve these problems, creating IoT devices to enable farmers to monitor the soil quality, pesticides and irrigation that could influence their crops.

5.2 Increased Traceability in the Supply Chain

The consumer's expectations of food standards are rising dramatically. More and more consumers are particularly interested in understanding where their food comes from. By using block chain technology, consumers are told exactly where their food came from, who planted it, how fresh it is. This just allows employees to review the commodity at any step of the process to update the database. Imagine purchasing something from the supermarket and finding out more about the product only by using your mobile application to check the bar code. Increasing the traceability of the supply chain will have a considerable impact in reducing food fraud, false labelling, and cutting intermediaries out of the process to ensure producers get paid fairly for their efforts and that consumers know exactly what they're paying for. Enhanced traceability will assist families to monitor their crops and to keep track of them via their planting, harvesting, storage and delivery processes by simply using an app from the app store, so that they can always see the accuracy of their product status and, where necessary, make adjustments. Given that approximately one third of the human-produced food about 1.3 billion tons is wasted every year, this innovation is long overdue. Some farmers in Australia have already used blockchain for tracking their production and waste reduction.

5.3 Increased Efficiency for Farmers

Many of the landowners presently use a blend of a variety of applications, tablets, and documents formed by software developers for their information recording and management practices. This is complex, even so, and involves a huge amount of effort to send this information to other suppliers. Block chain will indeed make it possible for farmers to save all one's information in one place, so that people that need it can reach it easily, simplifies the actual system and saves valuable energy and time.

They could, for example, track things like:

- Their business objectives and how they plan to achieve these objectives. The lot of living creatures, health issues, what they have been eating or how often they are eating Since they've been planting and just how they conduct, how many plant species are present.
- Your schedule for your employee, the amount of pay to each staff and the number of hours each staff worked.
- Revenue and expenditure. Regular monitoring of all in a single platform rather than of various methods explains the procedure and reduces the likelihood of critical data becoming lost.

5.4 Fairer Payment for Farmers

Many other real issues make it impossible for growers to be paid for agricultural goods. With that said, growers often need days to meet their demands in full. And to complicate things worse, conventional payments – usually wire transfers – also account for a large portion of the farmers' profits. Intelligent agreements centered in Block chain project instantly when payments are triggered by the purchaser – without charge of extortionary transaction costs – once a pre-specific condition has been met. It implies that the producer will potentially get paid for his products as long since they are shipped without losing a large portion of his profits. Most producers also have hard time selling their goods at a reasonable price on the market. The intermediaries are actually earning most of the gains though doing little in comparison. Intelligent agreements will totally remove the need for such intermediaries as farmers are linked to merchants personally. They will then be able to get their products an equitable cost.

VI. FUTURE OF BLOCK CHAIN

The blockchain is a new emerging technology, and it will take some time to get full set of applications to be develop in agriculture sector. Though it is surely clearing that agriculture blockchain is having good opportunities. The global agriculture industry now worth more than \$2.4 trillion and involves more than one billion people worldwide (Akash Takyar, 2019). By considering blockchain a revolutionary technology, many government and non-government organization are collaborating with advance techniques implication to increase agriculture productivity. Some example are The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Eleven01 (India's indigenous blockchain platform) and KHETHINEXT (e-agriculture service provider) have collaborated with blockchain technology to increase agriculture productivity and income of small-scale farmers.

The main feature of blockchain technology is that it inhibits the presence of various mediators into the system by connecting both farmers and consumer directly. The absence of mediators into the system leads to the growth of agriculture sector in terms of higher profit of farmers, inexpensive transportation and effective food supply chain. The acceptance of blockchain technology will help to simplify data registry, the agriculture supply chain and would leads to better world economy. This platform will give farmers an opportunity to get fair prices for their crops by dispersing the power of MNC which do unfair practices like setting up higher prices and this will enhance market growth without intervention of mediators. The blockchain is linked with the opportunity of enormous increase in individual freedom and creativity.

VII. LIMITATIONS

There are mainly three limitations of agriculture block chain

Firstly, the transacting parties ought not be ignored, it helps to supply the block chain ledger with correct details. This might help the small-scale farming. The Information that is collected in farming process is uneven and owned by individual Farmer. Blockchain benefits may depend on the size of the farm. On the other hand, a Blockchain insurance market could be easily involved by smaller farms. However, for larger farms it might be more practical to capture and incorporate on-farm data. Thus, future research should predict which farm will benefit and which will be in loss due to introduction to Blockchain technologies.

The next drawback could be that it may be costly to access the data submitted to a blockchain which may impede the implementation of blockchain technology in the agricultural sector. It could be comparatively cheap to distribute the ledger itself, while the compilation of data needed to render the ledger usable, such as livestock animal DNA, may be pricey. Sampling may minimize costs but it needs a wide population of data collection items. This means that for larger farms, the average cost of collecting data is lower than for smaller ones, thus increasing the concern about increasing income inconsistently.

Third limitation is that blockchain does not directly mix with the existing traditional practices. In order to increase the chances of successful implementation the technology needs to be connected to the existing database. the tradition systems like it is also time-consuming to develop an application to utilize the blockchain technology. The middleware and communication protocol could be the key if moved parallel.

VIII. CONCLUSION

In this literature, it has portrayed that how the blockchain technology will change the agriculture sector by implementing new techniques. Blockchain is the technology have been used in many sectors such as information technology, trade market, banking, cloud data storing and now this technology is stepping its foot in the field of agriculture sectors. Blockchain technology is linked with Information and Communications Technology (ICT) to make the data record more secure and safe on centralized cloud computing platform. It is speeding up the agriculture data transaction recording system with easily accessible authorization. This technology provides update weather reports and also helps in monitoring the soil and crop conditions (nutrients, moisture, temperature, pH, humidity) with developed smartphone applications. We conclude in this review that the blockchain is revolutionary technology which is imparting different techniques in agriculture sector and it will be going to improve agriculture productivity and sustainability in near future.

REFERENCES

1. Abbasi, A.Z.; Islam, N.; Shaikh, Z.A. A review of wireless sensors and networks' applications in agriculture. *Comput. Stand. Interfaces* 2014, 36, 263–270.
2. Bartlett, A.C.; Andales, A.A.; Arabi, M.; Bauder, T.A. A smartphone app to extend use of a cloud-based irrigation scheduling tool. *Comput. Electron. Agric.* 2015, 111, 127–130.
3. DNV GL AS. Global Opportunity Report 2017. Available online: <http://www.globalopportunitynetwork.org/the-2017-global-opportunity-report.pdf>
4. Iansiti, M., and Lakhani, K. R. (2017). The truth about blockchain. *Harv. Bus. Rev.* 95, 118–127. doi: 10.3390/s19153267
5. Jagannathan, S.; Priyatharshini, R. In Smart farming system using sensors for agricultural task automation. In Proceedings of the IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), Chennai, India, 10–12 July 2015; pp. 49–53.
6. Jiang, J.A.; Wang, C.H.; Liao, M.S.; Zheng, X.Y.; Liu, J.H.; Chuang, C.L.; Hung, C.L.; Chen, C.P. A wireless sensor network-based monitoring system with dynamic convergecast tree algorithm for precision cultivation management in orchid greenhouses. *Precis. Agric.* 2016, 17, 766–785.
7. Kaddu, S., and Haumba, E. N. (2016). "Promoting ICT based agricultural knowledge management for increased production by smallholder rural farmers in Uganda: a case of Communication and Information Technology for Agriculture and Rural Development (CITARD), Butaleja," in Proceedings of the 22nd Standing Conference of Eastern, Central and Southern Africa Library and Information Associations (SCECSAL XXII), Butaleja, 243–252.

8. Lask, H. K. a. M. and owski (2017). "AGRICULTURE ON THE BLOCKCHAIN Sustainable Solutions for Food, Farmers, and Financing." A BLOCKCHAIN RESEARCH INSTITUTE LIGHTHOUSE CASE STUDY.
9. Lin, Y.P.; Chang, T.K.; Fan, C.; Anthony, J.; Petway, J.R.; Lien, W.Y.; Liang, C.P.; Ho, Y.F. Applications of information and communication technology for improvements of water and soil monitoring and assessments in agricultural areas—A case study in the taoyuan irrigation district. *Environments* 2017, 4, 6.
10. Perea, R.G.; Garcia, I.F.; Arroyo, M.M.; Diaz, J.A.R.; Poyato, E.C.; Montesinos, P. Multiplatform application for precision irrigation scheduling in strawberries. *Agric. Water Manag.* 2017, 183, 194–201.
11. Suthar TR, Sanghvi RV, Nair TK, Devkatte AN and Chaudhari DN (2019). Review and Future Prospects for Lab-Grown Meat. *Research Review International Journal of Multidisciplinary* Volume 4 Issue 4 Page 1885-1892. RRIJM190404399
12. Sylvester, G. (2019). "E-agriculture in action: Blockchain for agriculture opportunities and challenges." Food and Agriculture Organization of the United Nations (FAO).
13. Vidya Sethy (2020). Top 13 Problems Faced by Indian Agriculture. Your Article Library (Accessed May 17, 2020) <http://www.yourarticlelibrary.com/agriculture/top-13-problems-faced-by-indian-agriculture/62852>
14. Walter, A., Finger, R., Huber, R., and Buchmann, N. (2017). Opinion: smart farming is key to developing sustainable agriculture. *Proc. Natl. Acad. Sci. U.S. A.* 114, 6148–6150. doi: 10.1073/pnas.1707462114
15. Yu, Q.Y.; Shi, Y.; Tang, H.J.; Yang, P.; Xie, A.K.; Liu, B.; Wu, W.B. eFarm: A tool for better observing agricultural land systems. *Sensors* 2017, 17.
16. Yu-Pin Lin , J. R. P., Johnathen Anthony , Hussnain Mukhtar , Shih-Wei Liao , and C.-F. C. a. Y.-F. Ho "Blockchain: The Evolutionary Next Step for ICT E-Agriculture." *Environments* 2017 4.
17. Zebi (2018). How Blockchain can Revolutionize the agriculture industry. Medium June 6, 2018 <https://medium.com/@Zebidata/how-blockchain-can-revolutionize-the-agriculture-industry-691d630dac61>
18. Akash Takyar (2019). BLOCKCHAIN IN AGRICULTURE – IMPROVING AGRICULTURAL TECHNIQUES. LeewayHertz <https://www.leewayhertz.com/blockchain-in-agriculture/>

